

CLAIMS

What is claimed is:

1           1.    An automated laser weld machine that welds  
2 together at least two photonic package components,  
3 comprising:

4           a laser station that can weld the photonic package  
5 components; and,

6           an automated handling assembly that can load and unload  
7 the photonic package components in said laser station.

1           2.    The machine of claim 1, wherein the photonic  
2 package components include a package and a fiber sleeve  
3 that are located in a horizontal position, said laser  
4 station includes three lasers that weld the fiber sleeve to  
5 the package.

1           3.    The machine of claim 2, wherein said laser station  
2 includes a package tooling that holds the package, said

3 package tooling having a yoke that can rotate about two  
4 orthogonal axis.

1 4. The machine of claim 3, wherein said package tooling  
2 includes an actuator to assert a biasing force to said  
3 yoke.

1 5. The machine of claim 3, wherein said package  
2 tooling includes a vibrator to apply vibratory energy to  
3 said yoke.

1 6. The machine of claim 3, wherein said package  
2 tooling includes a friction band that can lock a position  
3 of said yoke.

1 7. The machine of claim 6, wherein said package  
2 tooling includes a vacuum channel that pulls said friction  
3 band into said yoke.

1 8. The machine of claim 6, wherein said package  
2 tooling has a vacuum channel that pulls said friction band  
3 away from said yoke.





3 said package tooling having a yoke that can rotate about  
4 two orthogonal axis.

1 18. The machine of claim 17, wherein said package  
2 tooling includes an actuator to assert a biasing force to  
3 said yoke.

1 19. The machine of claim 17, wherein said package  
2 tooling includes a vibrator to apply vibratory energy to  
3 said yoke.

1 20. The machine of claim 17, wherein said package  
2 tooling includes a friction band that can lock a position  
3 of said yoke.

1 21. The machine of claim 20, wherein said package  
2 tooling includes a vacuum channel that pulls said friction  
3 band into said yoke.

1 22. The machine of claim 20, wherein said package  
2 tooling has a vacuum channel that pulls said friction band  
3 away from said yoke.



1           28. The machine of claim 27, wherein said actuator can  
2 vary a force applied by the fiber sleeve to the package.

1           29. An automated laser weld machine that welds  
2 together at least two photonic package components,  
3 comprising:

4           a first fixture that can a hold first photonic package  
5 component in a horizontal position;

6           a second fixture that can hold a second photonic  
7 package component in a horizontal position adjacent to the  
8 first photonic package component;

9           a first laser that can emit a light beam to weld the  
10 first and second photonic package components;

11          a second laser that can emit a light beam to weld the  
12 first and second photonic package components; and,

13          a third laser that can emit a light beam to weld the  
14 first and second photonic package components.

1        30. The machine of claim 29, wherein the first  
2 photonic package component is a package and the second  
3 photonic package component includes a fiber sleeve attached  
4 to a fiber.

1        31. The machine of claim 30, wherein said first  
2 fixture has a yoke that can rotate about two orthogonal  
3 axis.

1        32. The machine of claim 31, wherein said first fixture  
2 includes an actuator to assert a biasing force to said  
3 yoke.

1        33. The machine of claim 31, wherein said first  
2 fixture includes a vibrator to apply vibratory energy to  
3 said yoke.

1        34. The machine of claim 31, wherein said first  
2 fixture includes a friction band that can lock a position  
3 of said yoke.



1           35. The machine of claim 34, wherein said first  
2 fixture includes a vacuum channel that pulls said friction  
3 band into said yoke.

1           36. The machine of claim 35, wherein said first  
2 fixture has a vacuum channel that pulls said friction band  
3 away from said yoke.

1           37. The machine of claim 31, wherein said first  
2 fixture has a plurality of first electrical contacts that  
3 can be coupled to the package, and an actuator that moves  
4 said electrical contacts.

1           38. The machine of claim 37, wherein said first  
2 fixture includes a plurality of second contacts that can be  
3 coupled to said first contacts, and an actuator to move  
4 said second contacts relative to said yoke.

1           39. The machine of claim 34, wherein said first  
2 fixture includes a pair of rotary couplings that are pulled  
3 into said yoke with a vacuum pressure.

1           40. The machine of claim 31, wherein said second  
2 fixture includes an actuator to move the fiber sleeve into  
3 the package.

1           41. The machine of claim 40, wherein said actuator can  
2 vary a force applied by the fiber sleeve to the package.

1           42. An automated laser weld machine that welds  
2 together at least two photonic package components,  
3 comprising:

4           first fixture means for holding a first photonic  
5 package component in a horizontal position;

6           second fixture means for holding a second photonic  
7 package component in a horizontal position adjacent to the  
8 first photonic package component;

9           first welding means for welding the first and second  
10 photonic package components;

11 second welding means for welding the first and second  
12 photonic package components; and,

13 third welding means for welding the first and second  
14 photonic package components.

1 43. The machine of claim 42, wherein the first  
2 photonic package component is a package and the second  
3 photonic package component includes a fiber sleeve attached  
4 to a fiber.

1 44. The machine of claim 43, wherein said first  
2 fixture means includes a yoke that can rotate about two  
3 orthogonal axis.

1 45. The machine of claim 44, wherein said first fixture  
2 means includes an actuator to assert a biasing force to  
3 said yoke.

1 46. The machine of claim 44, wherein said first  
2 fixture means includes a vibrator to apply vibratory energy  
3 to said yoke.

1           47. The machine of claim 44, wherein said first  
2 fixture means includes a friction band that can lock a  
3 position of said yoke.

1           48. The machine of claim 47, wherein said first  
2 fixture means includes a vacuum channel that pulls said  
3 friction band into said yoke.

1           49. The machine of claim 47, wherein said first  
2 fixture means includes a vacuum channel that pulls said  
3 friction band away from said yoke.

1           50. The machine of claim 44, wherein said first  
2 fixture means includes a plurality of first electrical  
3 contacts that can be coupled to the package, and an  
4 actuator that moves said electrical contacts.

1           51. The machine of claim 50, wherein said first  
2 fixture means includes a plurality of second contacts that  
3 can be coupled to said first contacts, and an actuator to  
4 move said second contacts relative to said yoke.

1           52. The machine of claim 44, wherein said first  
2 fixture means includes a pair of rotary couplings that are  
3 pulled into said yoke with a vacuum pressure.

1           53. The machine of claim 44, wherein said second  
2 fixture means includes an actuator to move the fiber sleeve  
3 into the package.

1           54. The machine of claim 53, wherein said actuator can  
2 vary a force applied by the fiber sleeve to the package.

1           55. An automated laser weld machine that welds  
2 together at least two photonic package components,  
3 comprising:

4           a first tooling that can hold a first photonic package  
5 component in a horizontal position, said first tooling  
6 having a yoke that can rotate about two orthogonal axis and  
7 an actuator that applies a biasing force to said yoke;

8 a second tooling that can hold a second photonic  
9 package component in a horizontal position adjacent to the  
10 first photonic package component; and,

11 a laser that can emit a light beam to weld the first  
12 and second photonic package components.

1 56. The machine of claim 55, wherein the first  
2 photonic package component is a package and the second  
3 photonic package component includes a fiber sleeve attached  
4 to a fiber.

1 57. The machine of claim 55, wherein said first  
2 tooling includes a vibrator to apply vibratory energy to  
3 said yoke.

1 58. The machine of claim 55, wherein said first  
2 tooling includes a friction band that can lock a position  
3 of said yoke.

1           59. The machine of claim 58, wherein said first  
2 tooling includes a vacuum channel that pulls said friction  
3 band into said yoke.

1           60. The machine of claim 58, wherein said first  
2 tooling has a vacuum channel that pulls said friction band  
3 away from said yoke.

1           61. The machine of claim 56, wherein said first  
2 tooling has a plurality of first electrical contacts that  
3 can be coupled to the package, and an actuator that moves  
4 said electrical contacts.

1           62. The machine of claim 61, wherein said first  
2 fixture includes a plurality of second contacts that can be  
3 coupled to said first contacts, and an actuator to move  
4 said second contacts relative to said yoke.

1           63. The machine of claim 55, wherein said first  
2 tooling includes a pair of rotary couplings that are pulled  
3 into said yoke with a vacuum pressure.

64. The machine of claim 56, wherein said second tooling includes an actuator to move the fiber sleeve into the package.

65. The machine of claim 64, wherein said actuator can vary a force applied by the fiber sleeve to the package.

66. An automated laser weld machine that welds together at least two photonic package components, comprising:

a first tooling that can hold a first photonic package component in a horizontal position, said first tooling having a yoke that can rotate about two orthogonal axis and biasing means for applying a biasing force to said yoke;

a second tooling that can hold a second photonic package component in a horizontal position adjacent to the first photonic package component; and,

a laser that can emit a light beam to weld the first and second photonic package components.



1           67. The machine of claim 66, wherein the first  
2 photonic package component is a package and the second  
3 photonic package component includes a fiber sleeve attached  
4 to a fiber.

1           68. The machine of claim 66, wherein said first  
2 tooling includes a vibrator to apply vibratory energy to  
3 said yoke.

1           69. The machine of claim 66, wherein said first  
2 tooling includes a friction band that can lock a position  
3 of said yoke.

1           70. The machine of claim 69, wherein said first  
2 tooling includes a vacuum channel that pulls said friction  
3 band into said yoke.

1           71. The machine of claim 69, wherein said first  
2 tooling has a vacuum channel that pulls said friction band  
3 away from said yoke.

1           72. The machine of claim 67, wherein said first  
2 tooling has a plurality of first electrical contacts that  
3 can be coupled to the package, and an actuator that moves  
4 said electrical contacts.

1           73. The machine of claim 72, wherein said first  
2 tooling includes a plurality of second contacts that can be  
3 coupled to said first contacts, and an actuator to move  
4 said second contacts relative to said yoke.

1           74. The machine of claim 66, wherein said first  
2 tooling includes a pair of rotary couplings that are pulled  
3 into said yoke with a vacuum pressure.

1           75. The machine of claim 67, wherein said second  
2 tooling includes an actuator to move the fiber sleeve into  
3 the package.

1           76. The machine of claim 75, wherein said actuator can  
2 vary a force applied by the fiber sleeve to the package.

1        77. An automated laser weld machine that welds  
2 together at least two photonic package components,  
3 comprising:

4        a first tooling that can hold a first photonic package  
5 component in a horizontal position, said first tooling  
6 having a yoke that can rotate about two orthogonal axis and  
7 a friction band that can lock and unlock said yoke;

8        a second tooling that can hold a second photonic  
9 package component in a horizontal position adjacent to the  
10 first photonic package component; and,

11       a laser that can emit a light beam to weld the first  
12 and second photonic package components.

1       78. The machine of claim 77, wherein the first  
2 photonic package component is a package and the second  
3 photonic package component includes a fiber sleeve attached  
4 to a fiber.

1           79. The machine of claim 77, wherein said first  
2 tooling includes a vibrator to apply vibratory energy to  
3 said yoke.

1           80. The machine of claim 77, wherein said first  
2 tooling includes a vacuum channel that pulls said friction  
3 band into said yoke.

1           81. The machine of claim 77, wherein said first  
2 tooling has a vacuum channel that pulls said friction band  
3 away from said yoke.

1           82. The machine of claim 78, wherein said first  
2 tooling has a plurality of first electrical contacts that  
3 can be coupled to the package, and an actuator that moves  
4 said electrical contacts.

1           83. The machine of claim 82, wherein said first  
2 tooling includes a plurality of second contacts that can be  
3 coupled to said first contacts, and an actuator to move  
4 said second contacts relative to said yoke.

1           84. The machine of claim 77, wherein said first  
2 tooling includes a pair of rotary couplings that are pulled  
3 into said yoke with a vacuum pressure.

1           85. The machine of claim 78, wherein said second  
2 tooling includes an actuator to move the fiber sleeve into  
3 the package.

1           86. The machine of claim 85, wherein said actuator can  
2 vary a force applied by the fiber sleeve to the package.

1           87. An automated laser weld machine that welds  
2 together at least two photonic package components,  
3 comprising:

4           a first tooling that can hold a first photonic package  
5 component in a horizontal position, said first tooling  
6 having a yoke that can rotate about two orthogonal axis and  
7 lock means for locking and unlocking said yoke;

8 a second tooling that can hold a second photonic  
9 package component in a horizontal position adjacent to the  
10 first photonic package component; and,

11 a laser that can emit a light beam to weld the first  
12 and second photonic package components.

1 88. The machine of claim 87, wherein the first  
2 photonic package component is a package and the second  
3 photonic package component includes a fiber sleeve attached  
4 to a fiber.

1 89. The machine of claim 87, wherein said first  
2 tooling includes a vibrator to apply vibratory energy to  
3 said yoke.

1 90. The machine of claim 87, wherein said lock means  
2 includes a friction band that is pulled into said yoke.

1 91. The machine of claim 90, wherein said lock means  
2 includes a vacuum channel that pulls said friction band  
3 away from said yoke.

1           92. The machine of claim 88, wherein said first  
2 tooling has a plurality of first electrical contacts that  
3 can be coupled to the package, and an actuator that moves  
4 said electrical contacts.

1           93. The machine of claim 92, wherein said first  
2 tooling includes a plurality of second contacts that can be  
3 coupled to said first contacts, and an actuator to move  
4 said second contacts relative to said yoke.

1           94. The machine of claim 87, wherein said first  
2 tooling includes a pair of rotary couplings that are pulled  
3 into said yoke with a vacuum pressure.

1           95. The machine of claim 87, wherein said second  
2 tooling includes an actuator to move the fiber sleeve into  
3 the package.

1           96. The machine of claim 95, wherein said actuator can  
2 vary a force applied by the fiber sleeve to the package.

1           97. An automated laser weld machine that welds  
2 together at least two photonic package components,  
3 comprising:

4           a first tooling that can hold a first photonic package  
5 component in a horizontal position, said first tooling  
6 having a yoke that can rotate about two orthogonal axis, a  
7 first plurality of contacts that can engage the package, a  
8 second plurality of contacts, and an actuator that can move  
9 said second plurality of contacts into said yoke so that  
10 said second plurality of contacts are electrically coupled  
11 to said first plurality of contacts;

12           a second tooling that can hold a second photonic  
13 package component in a horizontal position adjacent to the  
14 first photonic package component; and,

15           a laser that can emit a light beam to weld the first  
16 and second photonic package components.



1           98. The machine of claim 97, wherein the first  
2 photonic package component is a package and the second  
3 photonic package component includes a fiber sleeve attached  
4 to a fiber.

1           99. The machine of claim 97, wherein said first  
2 tooling includes a vibrator to apply vibratory energy to  
3 said yoke.

1           100. The machine of claim 97, wherein said first  
2 tooling includes a pair of rotary couplings that are pulled  
3 into said yoke with a vacuum pressure.

1           101. The machine of claim 98, wherein said second  
2 tooling includes an actuator to move the fiber into the  
3 package.

1           102. The machine of claim 101, wherein said actuator  
2 can vary a force applied by the fiber sleeve to the  
3 package.

1           103. An automated laser weld machine that welds  
2 together at least two photonic package components,  
3 comprising:

4           a first tooling that can hold a first photonic package  
5 component, said first tooling having a yoke that can rotate  
6 about two orthogonal axis, a first plurality of contacts  
7 that can engage the package, and actuator means for  
8 coupling a second plurality of contacts to said first  
9 plurality of contacts;

10           a second tooling that can hold a second photonic  
11 package component adjacent to the first photonic package  
12 component; and

13           a laser that can emit a light beam to weld the first  
14 and second photonic package components.

1           104. The machine of claim 103, wherein the first  
2 photonic package component is a package and the second

3 photonic package component includes a fiber sleeve attached  
4 to a fiber.

1 105. The machine of claim 103, wherein said first  
2 tooling includes a vibrator to apply vibratory energy to  
3 said yoke.

1 106. The machine of claim 103, wherein said first  
2 tooling includes a pair of rotary couplings that are pulled  
3 into said yoke with a vacuum pressure.

1 107. The machine of claim 104, wherein said second  
2 tooling includes an actuator to move the fiber sleeve into  
3 the package.

1 108. The machine of claim 107, wherein said actuator  
2 can vary a force applied by the fiber sleeve to the  
3 package.

1 109. An automated laser weld machine that welds  
2 together at least two photonic package components,  
3 comprising:

4 a first tooling that can hold a first photonic package  
5 component, said first tooling having a yoke that can rotate  
6 about a plurality of bearings, a friction band that locks a  
7 position of said yoke with a vacuum pressure that also  
8 moves and seals said bearings;

9 a second tooling that can hold a second photonic  
10 package component adjacent to the first photonic component;  
11 and,

12 a laser that can emit a light beam to weld the first  
13 and second photonic package components.

1 110. The machine of claim 109, wherein the first  
2 photonic package component is a package and the second  
3 photonic package component includes a fiber sleeve attached  
4 to a fiber.

1 111. The machine of claim 109, wherein said first  
2 tooling includes a vibrator to apply vibratory energy to  
3 said yoke.

1        112. The machine of claim 110, wherein said second  
2 tooling includes an actuator to move the fiber sleeve into  
3 the package.

1        113. The machine of claim 112, wherein said actuator  
2 can vary a force applied by the fiber sleeve to the  
3 package.

1        114. A method for welding a first photonic package  
2 component to a second photonic package component,  
3 comprising:

4        loading a first photonic package component onto a first  
5 tooling with a robotic arm;

6        loading a second photonic package component onto a  
7 second tooling with the robotic arm; and,

8        welding the second photonic package component to the  
9 first photonic package component.

1        115. The method of claim 114, wherein the first and  
2        second photonic package components are welded in a  
3        horizontal position.

1        116. The method of claim 115, wherein the first and  
2        second photonic package components are welded with three  
3        lasers.

115. The method of claim 114, wherein the first and  
second photonic package components are welded in a  
horizontal position.